

REMARKS

In response to the Office Action mailed December 2, 2004, Applicant amends his application and requests reconsideration. No claims are added or cancelled so that claims 2-4 remain pending.

In preparing this response, an error in the Preliminary Amendment was discovered. In the amendment of claim 3, in the Preliminary Amendment, the word "thickness" was added but the addition was not indicated by an underline. This oversight is sincerely regretted. It is, however, apparent that the process of removing a natural oxide film with hydrogen fluoride and the formation of a thin oxide film with hydrogen peroxide is directed to forming a thin film of essentially uniform thickness as described in the patent application in the paragraph bridging pages 10 and 11. Further, the description of a similar process in Chien et al. (U.S. Patent 5,328,867, hereinafter Chien) makes clear that the oxide film thus formed has an essentially uniform thickness. In view of the language of claim 3 as amended, but not indicated as amended, in the Preliminary Amendment, in this Amendment conforming amendments are made to claims 2 and 4.

Claim 2 was rejected as indefinite. The final paragraph of claim 2 has been amended for clarity and to overcome the rejection. Support for the amendment of the final paragraph of claim 2 is found in the application from page 11, line 28 to page 12, line 4. As described in that passage, in the rapid thermal annealing process, a process that occurs at a relatively high temperature for a relatively short time, the uniform thickness oxide film is broken, essentially the film opens, at least temporarily, so that the diffusing implanted dopant ions can reach the underlying doped region, i.e., the n-type emitter layer 9 in the embodiment described in the patent application. The diffusing dopant ensures a good electrical contact between the second poly-silicon film and the impurity doped region, i.e., extending through the first poly-silicon film. The clearer explanation of the final step in amended claim 2 clearly overcomes the rejection of the claim as to form.

Claims 2-4 were rejected under 35 U.S.C. 103(a) as being unpatentable over the prior art described in the patent application in view of Chien and Nagatomo (U.S. Patent No. 5,194,404 hereinafter Nagatomo). This rejection is respectfully traversed.

Independent claim 2 is directed to a method of manufacturing a semiconductor device comprising, forming a thin uniform thickness oxide film that is heat treated in a rapid thermal annealing process. As described in the patent application in the paragraph bridging pages 11 and 12, in that rapid thermal annealing process, a relatively high temperature process that is carried out for a relatively short period of time, the integrity of the uniform thickness oxide

film is destroyed, at least temporarily. As described in the cited paragraph of the patent application, the process produces viscous flow of the oxide film. Regardless of the mechanism, the important result of the rapid thermal annealing process is the diffusion of dopant impurities establishing improved electrical conductivity between the second poly-silicon film and the impurity doped region. The result is an electrical connection, having relatively low resistance, between the upper or second poly-silicon film and the impurity doped region, which is the emitter of a bipolar transistor in the embodiment of the invention described in the patent application. The rejection is respectfully traversed because there is no suggestion for the invention in the prior art applied in rejecting the claims.

The prior art described in the patent application does not describe the formation of a thin oxide film of uniform thickness on the impurity doped region that is an emitter region in the described embodiment. This failing of the prior art described in the patent application is conceded in the Official Action by the citation of Chien. Chien describes, as asserted in the Official Action, a complex cleaning process rather similar to the cleaning process described in the patent application. That process includes the removal of a natural or native oxide film from a silicon layer with HF and the formation of a relatively thin oxide film using hydrogen peroxide. However, as also conceded by the Official Action, there is no description of any rapid thermal annealing process in either the prior art described in the patent application or Chien. For that feature of the invention, reliance was placed entirely upon Nagatomo. This reliance is misplaced.

Nagatomo describes the formation of a contact structure in a semiconductor device. This contact structure, particularly described in Nagatomo with respect to its Figures 2A-2C and in column 3, is substantially different from anything described in the present patent application. What is expressly described by Nagatomo is the formation of a thin oxide film 36, not on a silicon film by treatment with hydrogen peroxide or by any other chemical reaction with an underlying silicon layer. The silicon oxide film is vapor deposited on a tungsten silicide (WSi) layer 25b. The WSi layer separates the thin oxide layer 36 from a poly-silicon film 33. As expressly described by Nagatomo, the surface of the WSi layer 25b is undulated, i.e., includes, in cross-section, hills and valleys. The hills and valleys are clearly apparent in each of Figures 2A-2C.

Nagatomo describes a rapid thermal annealing process in which the thin oxide layer 36 moves by viscous flow because of the presence of the hills and valleys of the WSi layer: "the oxide of the oxide layer 36 located on the hills of the WSi layer 25b moves to the valleys by viscous flow as shown in FIG. 2B...". Nagatomo further explains in the final sentence of column 3, which ends in column 4, that if the flow is insufficient, i.e., if the valleys are too

shallow, then the thin oxide film is not cleared from any part of the WSi film and there is a failure to make the intended contact. The important teaching of Nagatomo is that rapid thermal annealing is only effective to clear a part of an intervening thin oxide film if the underlying surface is uneven and provides a reservoir for collecting a flow, induced in the annealing process, of the thin oxide.

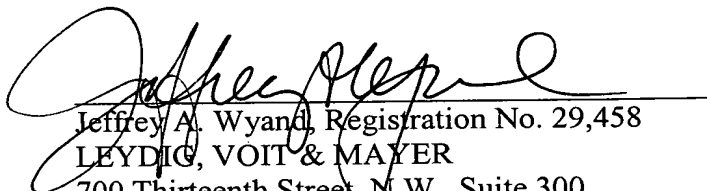
Even assuming that Chen could be properly used to modify the prior art described in the patent application, the teaching of Nagatomo is insufficient to establish *prima facie* obviousness of claim 2 or any other pending claim. The essential teaching of Nagatomo is the necessity of forming an uneven surface to achieve the desired viscous flow of the thin oxide film to provide access to an underlying layer. It is clear from the description in the present patent application and claim 2 that no uneven, i.e., non-planar, surface is formed at the emitter region. Rather, in the invention, the thin oxide film is deposited on a planar surface. Therefore, the teaching of Nagatomo is completely irrelevant to the claimed invention. Nagatomo never suggests that rapid thermal annealing of a thin oxide film will result in the formation of openings in the film through which a dopant impurity can diffuse when, as in the invention, the thin oxide film is essentially planar. Nagatomo teaches against the hypothetical modification of the prior art described in the patent application by Chien through the addition of a rapid thermal annealing process because Nagatomo requires an undulating surface supporting the thin oxide film, an undulating surface that is not present in Chien nor in the invention. Unlike Nagatomo, there are no reservoirs in the invention for collecting any viscously flowing oxide film.

From another perspective, it is apparent that there is no motivation within any of the prior art described in the patent application, Chien, or even Nagatomo itself, for making the modification hypothesized to establish *prima facie* obviousness of claims 2-5. No reference suggests that Nagatomo's technique is effective for a planar surface. Thus, the rejection applies an "obvious to try" standard for obviousness based on knowledge of the invention. That standard is legally incorrect and, even if applied, cannot establish *prima facie* obviousness for the reasons already explained. Therefore, upon reconsideration, the rejection should be withdrawn.

In re Appln. of Masaaki IKEGAMI
Application No. 10/650,677

Reconsideration and allowance of claims 2-5 are earnestly solicited.

Respectfully submitted,



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